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TRANSACTIONS.

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No. 892.

SOME PECULIAR RAILROAD BRIDGE ACCIDENTS.

By J. I. BOGGS, Assoc. M. Am. Soc. C. E.

PRESENTED DECEMBER 19TH, 1900.

WITH DISCUSSION.

Several years ago, while the writer was Division Engineer of Maintenance of Way on the Houston and Texas Central Railway, two or three accidents happened to the bridging under his charge, which may possibly be of some historical interest.

The first bridge, Fig. 1, a pin-connected Pratt truss over Richland Creek, of 128 ft. $7\frac{1}{2}$ ins. span, was built by the Phoenix Bridge Company, in the early part of 1887, and, as in all similar work by that company at that time, the posts and upper chords consisted of the old closed Phoenix columns, set into castings at the panel points.

The structure was at the foot of a stiff grade, and while a heavily loaded freight train, moving at a high rate of speed, was passing, a bale of cotton became dislodged and was hurled against the first post, marked "A," Fig. 1, with sufficient force to bend it 13 ins. out of line and knock it clear of the structure, thus leaving the truss with one of its main members missing.

At the time of the accident the structure was entirely covered by

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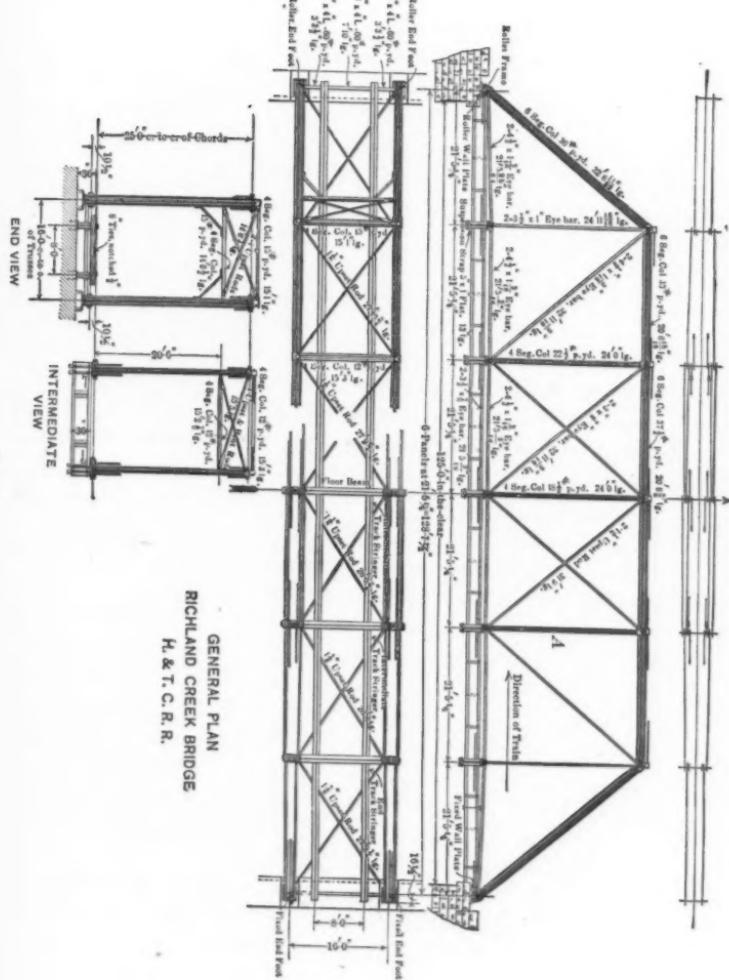


FIG. 2.

the train, weighing approximately 2 500 lbs. per lineal foot. Contrary to all expectations and calculations the bridge carried the remainder of the train, consisting of about twenty loaded cars, across in safety, although the main post was gone.

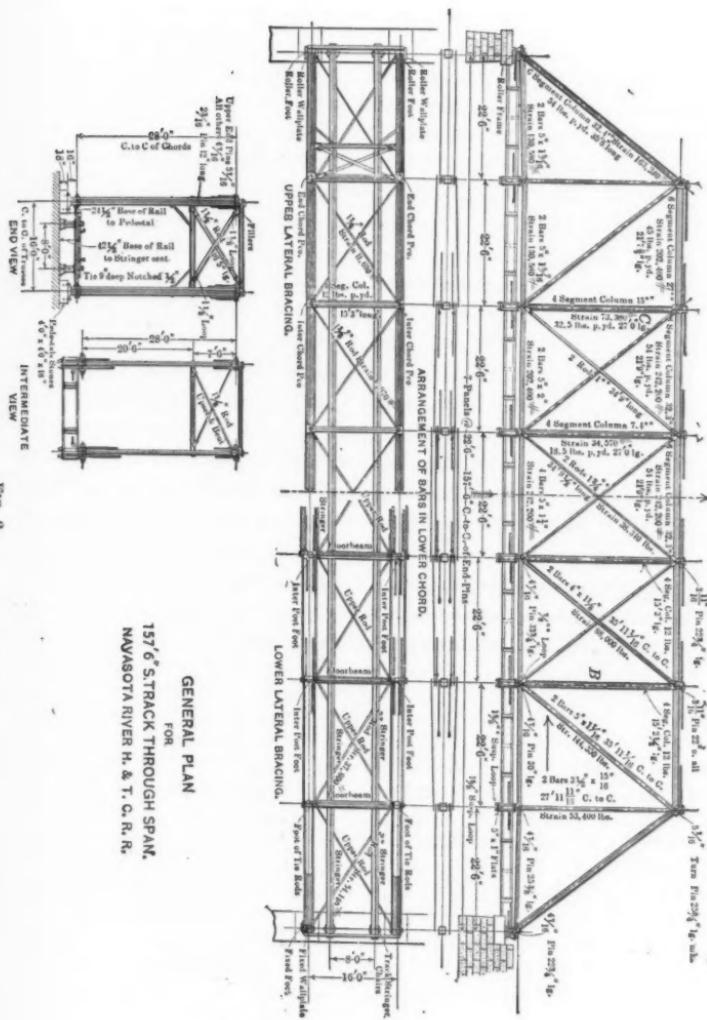
That there was a tremendous bending moment in the upper chord was shown by the following: As quickly as possible a 12 x 12-in. stick of timber, cut to accurate height, was fitted between the upper and lower castings, and a train allowed to pass; as soon as this train had crossed, it was found that the ends of the timber were so badly crushed that it was unfit for further service. A piece of $\frac{1}{2}$ -in. plate iron was then inserted between the castings and the timber. This did good service and continued in use until the original member had been taken to the shops, thoroughly repaired and replaced.

In the case of the Navasota River Bridge, Fig. 2, a similar structure, of 157 ft. 6 ins. span, the two posts marked "B" and "C," the former in the left, and the latter in the right-hand trusses, were likewise destroyed by two bales of cotton falling off the same train in opposite directions. Again the train crossed safely, the same steps were taken, and the posts were repaired and replaced.

In both cases the bridges were floored with 8 x 10-in. ties, spaced at 16-in. centers, and had 56-lb. rails.

There was another interesting occurrence at the Trinity River Bridge, a very light Whipple truss, of 130 ft. span, with panel lengths of 12 ft. 6 ins., built in 1877 by the same company. The writer regrets that he has no diagram of this structure. The only idea he can give of its frailty being the statement that the floor beams were only 20 ins. in depth, and the track stringers 7 x 14-in. wooden beams, packed three under each rail. In this instance part of a carload of lumber fell off and struck the first post, permanently bending it about 10 ins. out of the vertical. Several very heavy trains, both freight and passenger, with engines weighing 105 tons, passed over the bridge before the accident to the post was discovered.

The Richland Creek and Navasota River cases are interesting from the fact that it has sometimes been argued that no Pratt truss bridge would stand up under these conditions, and the writer very much doubts if it would if the connections were all rigid. If it did stand it is quite likely that the structure would be so disturbed that a good portion, if not all, would have to be replaced, and this would also



157' 6" S. TRACK THROUGH SPAN
NAVASOTA RIVER H. & T. C. R. R.

probably apply in the case of the floor beam riveted to the post above the chord.

The American pin-connected truss has become famous, the world over, and why American engineers should now incline to the rigid connections of their foreign brethren is, to say the least, remarkable. In the case of the pin-connected truss, where the load to be transmitted is 50 000 lbs., it is known that it must enter the pin, and the pin be designed accordingly, but in the rigid connection, with, say, a shear of 5 000 lbs., we find 10 rivets, two are thrown in for good measure, making twelve all told; these are distributed two, three, two, and so on. Now, how is the 5 000 lbs. distributed? Does each rivet carry an equal portion, or do the first five rivets take the greater part of the stress, producing secondary stresses which will eventually destroy the usefulness of the structure at a much earlier date than would the old pin-connected? At the hazard of being considered ancient, the writer has ventured on the above remarks, and, while not decrying modern methods, he is inclined to the opinion, that there was considerable inherent merit in the designs of our great predecessors, and that the design of later bridges can be seriously questioned; and as the former has stood the test of time, he thinks that it might be as well to hesitate somewhat before venturing too far into new fields.

The writer submits the foregoing as a matter of history and to show the remarkable performances of some of the old designs. He regrets that he has not the time to enter into a mathematical demonstration of cause and effect.

DISCUSSION.

JOSEPH MAYER, M. Am. Soc. C. E.—The pin-connected bridges Mr. Mayer described in the paper had a remarkable experience, and behaved certainly much better than their most enthusiastic advocate would venture to hope.

It is a curious fact that, while rigid connections are becoming the fashion in this country, they are abandoning them in Germany. The Rhein Bridge, in Worms, is an instance where, for the purpose of avoiding the secondary strains due to the loading of one track only, and the consequent larger deflection of one truss, the floor is freely suspended from the trusses above. The top struts are practically hinged, and there are no intermediate vibration bracings. The stringers have sliding connections to the floor beams to prevent the bending of the latter.

It cannot well be doubted that the secondary strains, which are very large in some members, like end suspenders and vertical posts with floor beams riveted between, could be largely reduced or altogether avoided by such connections. The speaker believes that the movement against hinges which is now in vogue in this country will be abandoned after trial and experience of the large secondary strains caused thereby.

PHILIP AYLETT, Assoc. M. Am. Soc. C. E. (by letter).—A few weeks Mr. Aylett ago there occurred, on an important railway system traversing the Southern States, one of the most remarkable bridge accidents of which the writer has knowledge.

This disaster occurred at the crossing of the railway over a small stream about 150 ft. in width, and with an average depth of 8 ft.

That portion of the structure over the channel consisted of a 50-ft. half-through girder span, while on the east and west approaches there were 1 232 ft. and 118 ft., respectively, of cypress pile trestling.

The spacing of the girders was 12 ft. from center to center of the webs, and the cross-ties or floor beams were of 12 × 12-in. × 12-ft. pine, resting on shelf angles riveted to the webs of the girders. There is a heavy ascending grade in both directions from the river, and it is presumed that trains attained a high rate of speed in crossing the stream in order to facilitate the climbing of the opposite grade.

The girders were supported by three pile-bents (cypress) under each end, each bent having five piles, these being sawed off and capped with two (criss-cross) layers of 12 × 12-in. timbers, drift-bolted to the piling, upon which the girders rested. The wooden portion of the structure had recently been rebuilt, and the girders were reported to have been in first-class condition and amply sufficient for any traffic to which they would be subjected.

On December 14th, 1901, while a local east-bound freight train, containing 38 cars loaded with cross-ties, lumber and naval stores, was

Mr. Aylett, crossing this stream, and after the engine and 8 cars had crossed the girder span, the girders were suddenly knocked from their seats by the derailed trucks or body of a box car, the ninth car from the engine, this car striking the end of the down-stream girder. The fall of the span precipitated 27 of the following cars into the river, breaking down the pile-bents of the west portion of the trestle until the wreckage had completely filled this space and was piled up over 50 ft. above the base of the rails. A flat car stood vertically at the summit of this pile of wreckage.

The box car which struck the girder became derailed some 250 ft. before reaching the trestle, as was indicated by the flange marks on the cross-ties, and the car was leaning well over to the right when it reached the girder span.

Upon striking the girder, the car knocked off its front cross-beam and lost both trucks, and, although loaded with cross-ties, passed over the opening and slid 60 ft. beyond, upon the undamaged portion of the trestle. The caboose and one car stopped at the foot of this mountain of wreckage.

The engine with eight cars passed over the girders safely before these were struck by the ninth car, which, although truckless, followed closely behind.

Five days were consumed in reopening the line for traffic, and it would have been impossible to have accomplished it in that time had not the wreckage been burned to the water level, while fire engines were kept constantly playing upon the adjacent undamaged trestle. Even after the wreckage had been burned to the water level, great difficulty was encountered in pile-driving on account of the sunken timber, barrels of resin, etc., the bed of the river being filled almost solidly with débris and naval stores.

The writer has always been of the opinion that "through girders" were subject to damage and accidents to a greater extent than "through truss spans" in the case of derailments, and has always been opposed to that abominable practice, so much resorted to in cheap through-girder construction, of resting the ties (or floor beams) upon bottom flanges, or angles riveted to the webs of the girders above the bottom flanges, in lieu of a complete floor system of metal floor beams and stringers with riveted connections.

In this case, however, the cause cannot be attributed, in any direct way, to the shelf-angle construction. The writer believes, however, that possibly this disaster would have been avoided had these girders been protected by inside bridge guards, and also probably avoided had the girders been spaced further apart.

It is the writer's practice to space "through girders" 14 ft. and over between centers of flanges of girders, using a steel floor system with riveted connections, all through girders having inside guards.

The direct cause of the derailment was a broken flange in one of the wheels of the ninth box car, portions of this flange being found 500 ft. from the west end of trestle approach.